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# DISCOVERY AND SIGNIFICANCE OF ALBANY HANCOCK'S MICROSCOPE PREPARATIONS OF EXCAVATING SPONGES (PORIFERA: HADROMERIDA: CLIONIDAE)

Klaus Rützler and Shirley M. Stone

*Abstract.*—A collection of 91 identified microscope slide preparations of clionid sponge species discovered at The Hancock Museum, Newcastle-upon-Tyne, U.K., is re-examined for the first time in over 100 years. The slides document the material described by Albany Hancock in two papers on "excavating sponges" (Hancock 1849, 1867). Except for *Cliona celata* Grant (seven slides) the collection can be considered type material for 27 species of *Cliona* and two species of *Thoosa* named by Hancock. This valuable discovery will be the basis for species revisions within the Clionidae henceforth.

Albany Hancock (1806–1873) trained as a lawyer but after two years in practice left (1833) to follow his first love, the study of natural history for which he had developed a distinct flair. During his 67 years, he wrote or co-authored over 70 papers on a wide range of animals.

Albany was a self-taught naturalist, developing a remarkable capacity for minute and accurate observation. He became an accomplished artist and a gifted anatomist showing meticulous skill in dissection. He distinguished himself in the field of malacology, where his studies culminated in the celebrated Ray Society "Monograph of the British Nudibranchiate Mollusca," published in collaboration with Joshua Alder in 1855. The colored plates, renowned both for their delicate beauty and accurate detail, were nearly all prepared by Hancock.

His studies convinced him that a sound classification depends on a knowledge of the living animal visualized functionally, in order better to appreciate the significance of the gross morphology. This rather advanced view is apparent in his sponge work. As early as 1845 he became interested in the mechanics of burrowing as demonstrated by various invertebrates. He studied molluscs and barnacles before turning his attention to the clionid sponges.

In the course of his study, Hancock (1849) not only developed important theories about the mechanisms by which sponges penetrate their substrate but also discovered that not all excavating sponges belong to one species, *Cliona celata* Grant, as had been assumed by his contemporaries. In fact, Hancock claimed to have "determined upwards of fifty species" of clionids, but he only described 25 in his first paper (Hancock 1849), including two belonging to his new genus *Thoosa*. "Twelve" of these species came from the British coasts, the rest from other parts of the world which were not always clearly stated, presumably because the mollusk shells studied lacked detailed data.

Hancock's (1849) descriptions were unusually detailed being based not only on the shape and size of spicules, but also on pattern and dimensions of papillary perforations and subsurface excavations, and on color of the live (when known) or dry specimens. Spicules of all species were drawn to the same scale and several excavation patterns were also illustrated. Unfortunately, Hancock overlooked most of the microscleres in his original temporary microscope

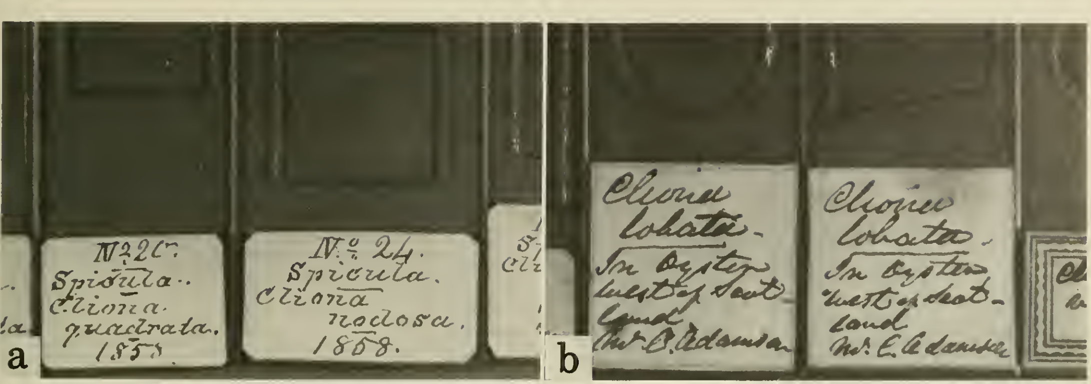

Fig. 1. A. Hancock slides, styles of handwriting: a, Style 1 by J. Alder; b, Style 2 by A. Hancock.

preparations. These taxonomically important spicules were not noted until about a decade later when Hancock re-examined his material and made permanent mounts of spicules and some tissue in Canada balsam. This renewed study was prompted by Hancock's continued curiosity about the excavation technique used by clionid sponges, thought to be mechanical and leaving visible traces in the form of substrate chips, and led to a follow-up publication (Hancock 1867). In this work the earlier diagnoses of nine British *Cliona* species were amended by description and illustration of their microscleres and four foreign species of *Cliona* were named and described. Another purpose of Hancock's (1867) paper was to defend his views on excavation powers and species diversity in clionids, both heavily criticised by his contemporary Bowerbank (1866).

As far as we know, neither Bowerbank nor other critics of Hancock's (1849, 1867) species concept, such as Topsent (1888, 1891) and Vosmaer (1933), examined the type preparations at the Newcastle Museum, as it was then known. When more recent attempts to reevaluate Hancock's work failed because neither Hancock's excavated shells nor his slides could be located, it was assumed that the entire collection was lost during the chaos of World War II.

However, after a visit by one of us (SMS) to The Hancock Museum late in 1970, three sets of Hancock's microscope slides (165 slides in all but not all identified) were discovered after a determined search by one of the resident curators. Of these, 91 named slides (excluding *C. celata* of Grant), representing all 27 *Cliona* species and the two *Thoosa* species described by Hancock (1849, 1867) have now been examined by us and, where possible, an opinion is given about the validity of the species. We regard all 91 slides as primary type material of Albany Hancock (holotypes by monotypy, or syntypes).

Many of the slides bear a number, written in the hand of the labeller, which we assume to be Hancock's coded number for the species because never more than one number is ever cited for a multi-specimen species. In the numbering sequence 1–46, five numbers (1, 19, 28, 29, 35) are not represented by slides at the present time. Slide labels are written in two different styles of handwriting. The first (style 1, Fig. 1a) is associated with "1858" when this date appears on the label, and the second (style 2, Fig. 1b) with the date "1867." Comparisons with labels of known origin in The Hancock Museum demonstrate that style 1 is by the hand of Joshua Alder, Hancock's friend and collaborator; style 2 is the handwriting of Albany Hancock himself (P. Davis, pers. comm.).

Catalog (registration) numbers in this text are those of The Hancock Museum, Newcastle-upon-Tyne.

## Annotated List of New Species Described by A. Hancock

In the following account Hancock's (1849, 1867) species are listed in alphabetical order. Comments on spicule types and shape and measurements of spicules are based on our own examination of the microscope slides. Spicule dimensions given by us are averaged total length × width of the most abundant size class for each type (for tylostyles, maximum shaft width, not head diameter, was taken). Measurements by the original author of the "full developed spiculum" (Hancock 1849:332) were converted from inches to micrometers and added with Hancock's initials (A.H.) in parentheses for comparison.

### *Cliona* Grant

### *Cliona alderi* Hancock

Fig. 2a

*Cliona Alderi* Hancock, 1849:337, pl. XV, fig. 9; 1867:239.

*Material examined.*—5 slides (3 tissue squash, 2 acid cleaned), from at least two specimens (A.H. no. 4); four dated 1858, one dated 1867.

*Syntypes.*—4.15.01–4.15.04.

*Additional material.*—4.15.05.

*Type locality.*—Isle of Man, Great Britain.

*Spicules.*—(a) Tylostyles with inconspicuous subterminal heads, 240 × 7 $\mu$m (A.H.: 219 $\mu$m). (b) Styles, 250 × 7 $\mu$m.

*Remarks.*—Spicules vary strongly in size and proportion of tylostyles: styles between preparations. Hancock considered the styles to be slightly shorter than the tylostyles. This species was synonymized with *Cliona celata* Grant by Bowerbank (1866:212). However, strong differences in tylostyle size and shape exist between this species and typical specimens of *Cliona celata* Grant described by Hancock (1849:332). These differences, as well as the occurrence of styles (and transition forms) suggest that *Cliona alderi* should be considered a valid species pending the discovery of more material.

### *Cliona angulata* Hancock

Fig. 2b

*Cliona angulata* Hancock, 1849:343, pl. XV, fig. 13.

*Material examined.*—1 slide (acid cleaned), containing only few and mostly broken spicules; A.H. no. 16, dated 1858.

*Syntype.*—4.15.06.

*Type locality.*—Mediterranean Sea.

*Spicules.*—Tylostyles with inconspicuous irregular and often ill-defined subterminal heads, some with one step near the point, some styloid forms, 210 × 5 $\mu$m (A.H.: 217 $\mu$m).

*Remarks.*—Considered a synonym of *Cliona celata* Grant by Topsent (1900:32). The existing preparation is insufficient for upholding this species.

### *Cliona canadensis* Hancock

Fig. 6e, f

*Cliona Canadensis* Hancock, 1849:340, pl. XIV, fig. 10.

*Material examined.*—4 slides (acid cleaned) from one specimen; only three of the slides conform with description of the species; A.H. no. 3, dated 1858.

*Holotype* (by monotypy).—4.15.07–4.15.09.

*Type locality.*—Not stated (substrate: "*Ostrea Canadense*").

*Spicules.*—(a) Tylostyles, many with subterminal heads, 190 × 5 $\mu$m (A.H.: 180 $\mu$m); a second, larger type (260 × 7 $\mu$m) with elongate, inconspicuous terminal head is probably foreign. (b) Oxea, microspined, many with centrotyl swelling, 120 × 5 $\mu$m. (c) Microrhabds, spiny, many centrotyl, 12 × 2 $\mu$m.

*Remarks.*—Vosmaer (1933:403, 411) tentatively synonymized this species with *Cliona vastifica* Hancock, suspecting that microrhabds ("spinispirae") may have been overlooked during the original description. The type slides indeed contain microrhabds. A fourth slide 4.15.10 with the same inscription as the two above contains spicules of an entirely different *Cliona* (very thin tylostyles with subterminal head, 200 × 2 μm; spiny microrhabds and amphiasters, 10 × 2 μm).

### *Cliona carpenteri* Hancock
Fig. 4a, b

*Cliona Carpenteri* Hancock, 1867:241, pl. VIII, fig. 4.

*Material examined.*—2 slides (acid cleaned) from one specimen (without A.H. no.); labelled by Hancock (style 2), dated 1867.

*Holotype* (by monotypy).—4.15.11, 4.15.12.

*Type locality.*—Mazatlan (Pacific Mexico).

*Spicules.*—(a) Tylostyles with rounded heads, 250 × 5 μm (A.H.: 254 μm). (b) Oxea, two size classes, 130 × 10 μm (A.H.: 127 μm; smaller category not mentioned and probably not considered "full developed"), and 63 × 4 μm; both with rough surface (difficult to detect in regular transmitted light) and including many centrotyi forms. (c) Microrhabds, straight and spiny, 13 × 3 μm (A.H.: 13 μm).

*Remarks.*—Topsent (1888:77; 1891:566) treats this as a good species, particularly pointing out the straight fusiform shape of the microscleres to distinguish it from *Cliona vastifica* Hancock. The two size classes of oxea have not been noted before.

### *Cliona cervina* Hancock
Fig. 6h

*Cliona cervina* Hancock, 1849:339, pl. XV, fig. 8.

*Material examined.*—1 slide (acid cleaned), A.H. no. 9, dated 1858.

*Syntype.*—4.15.19.

*Type locality.*—Not stated (substrate: "*Meleagrina albina*?").

*Spicules.*—(a) Tylostyles with flattened head, 250 × 5 μm (A.H.: 254 μm). (b) Oxea, tuberculated, 55 × 5 μm (A.H.: 64 μm); as shown by Hancock's figure they have a large range of lengths (40–80 μm). (c) Microrhabds bearing microspine clusters, straight, twisted or spiral, 20 × 4 μm and 7 × 2 μm.

*Remarks.*—As suspected by Vosmaer (1933:411) Hancock overlooked the microscleres in this sponge. However, the shape and size range of the oxea and the size range and variety of microrhabds and spirasters do not suggest identity with *Cliona vastifica* Hancock.

### *Cliona corallinoides* Hancock
Fig. 5a, b

*Cliona corallinoides* Hancock, 1849:337, pl. XV, figs. 1 & 2; 1867:238, pl. VII, fig. 3.

*Material examined.*—5 slides; two dated 1858 and labelled in style 1 (acid cleaned, A.H. no. 8); two in style 2 handwriting, dated 1867, labelled "In *Pecten maximus,* Jersey, Mr. H. T. Mennell" (squash preparation) and "In *Tapes virginia,* M. H. T. Mennell" (acid cleaned); one with style 2 label but without information other than the queried species name (acid cleaned).

*Syntypes.*—4.15.20, 4.15.21

*Additional material.*—4.15.22–4.15.24.

*Type locality.*—Britain.

*Spicules.*—(a) Tylostyles with knobbed or subterminal heads, 300 × 4 μm (maximum length 350 μm; A.H.: 363 μm) (b) Oxea, microspined, 100 × 2.5 μm (A.H.: 73 μm/121 μm): (c) microrhabds, spiny, 11 × 12 μm (A.H.: 13 μm), straight, S-shaped, W-shaped and spiralled. The H. T. Mennell slides (4.15.22, 4.15.23) contain identical spicules except that the tylostyles are smaller (230 × 3 μm).

*Remarks.*—This species is generally considered a junior synonym of *Cliona vastifica* Hancock (Topsent 1891:558, 564; Vosmaer 1933:402, 407).

### *Cliona dendritica* Hancock
Fig. 4c, d

*Cliona dendritica* Hancock, 1849:340, pl. XII, fig. 5; pl. XV, fig. 4.

*Material examined.*—1 slide (tissue squash); A.H. no. 7, dated 1858.

*Syntype.*—4.15.25.

*Type locality.*—Not stated (substrate: "*Patella Mexicana*").

*Spicules.*—(a) Tylostyles small with rounded or ovate heads, 160 × 4 μm (A.H.: 145 μm). (b) Oxea, microspined, 70 × 2.5 μm. (c) Microrhabds, spiny, seemingly two size classes: stout, 14 × 3 μm, pointed on both ends or rounded at one, many centrotyl; slender, 14 × 1 μm.

*Remarks.*—The microrhabds were not noted by the original author. Vosmaer (1933: 41), suspecting this oversight, considers this species a synonym of *Cliona vastifica* Hancock.

### *Cliona fryeri* Hancock
Fig. 5g, h

*Cliona Fryeri* Hancock, 1849:338, pl. XIV, figs. 2–4 & 9.

*Material examined.*—2 slides (acid cleaned) of the same specimen; both contain only very few spicules; A.H. no. 41, dated 1858.

*Syntypes.*—4.15.26, 4.15.27.

*Type locality.*—Not stated (substrate: "*Placuna placenta*").

*Spicules.*—(a) Tylostyles, with oval heads, 200 × 4.5 μm (A.H.: 219 μm). (b) Oxea, microspined, very rare, 75 × 3 μm. (c) Microrhabds, spiny, W-shaped or spiral, with up to five bends, 10–15 × 2 μm.

*Remarks.*–No microrhabds were originally described. Vosmaer (1933:411) considers this species identical with *Cliona vastifica* Hancock.

### *Cliona globulifera* Hancock
Fig. 2c

*Cliona globulifera* Hancock, 1867:240, pl. VIII, fig. 3.

*Material examined.*—1 slide (acid cleaned); without A.H. no., labelled in style 2, dated 1867.

*Holotype* (by monotypy).—4.15.28.

*Type locality.*—Mediterranean Sea.

*Spicules.*—Tylostyles only, with subterminal heads, 320 × 6 μm. Most heads are 10–25 μm removed from the rounded end; there are also multiple swellings.

*Remarks.*—Lendenfeld (1896:100) synonymized this species with *Papillella suberea* (*Cliona celata* Grant).

### *Cliona gorgonioides* Hancock
Fig. 2d

*Cliona gorgonioides* Hancock, 1849:333, pl. XIV, figs. 1 & 6; 1867:237.

*Material examined.*—6 slides (acid cleaned); all without A.H. nos., labelled in style 1 and dated 1858.

*Syntypes.*—4.15.29–4.15.34.

*Type localities.*—Northumberland (England) and Prestonpans (Scotland).

*Spicules.*—Tylostyles only, with subterminal heads, 270 × 7 μm (A.H.: 270 μm).

*Remarks.*—Already Hancock (1867:237) considered this species "probably a mere variety of *C. celata*"; several subsequent authors agreed (Vosmaer 1933:349, 361).

### *Cliona gracilis* Hancock
Fig. 5c, d

*Cliona gracilis* Hancock, 1849:334, pl. XIV, fig. 7; 1867:238, pl. VII, fig. 4.

*Material examined.*—2 slides (1 acid cleaned, A.H. no. 39, labelled in style 1, dated 1858; 1 squash without A.H. no., labelled in style 2, dated 1867 but denoted "From original specimen").

*Holotype* (by monotypy).—4.15.35, 4.15.36.

*Type locality.*—"Probably from Orkney," northern Scotland.

*Spicules.*—(a) Tylostyles, with rounded heads, 330 × 5 μm (A.H.: 330 μm). (b) Oxea, microspined, 110 × 3 μm (A.H.: 10 μm).

(c) Microrhabds, spiny, zigzagged, 18 × 2 μm (A.H.: 17 μm).

*Remarks.*—Topsent (1891:565) considers this species to be a synonym of *Cliona vastifica* Hancock, a view also maintained by Vosmaer (1933:402, 406).

### *Cliona howsei* Hancock
Fig. 3a, b

*Cliona Howsei* Hancock, 1849:336, pl. XIV, fig. 8; 1867:238, pl. VII, fig. 5.

*Material examined.*—3 slides (acid cleaned); A.H. no. 36 (2 slides), all dated 1858.

*Syntypes.*—4.15.37–4.15.39.

*Type localities.*—Northeastern and south coasts of England.

*Spicules.*—(a) Tylostyles, with subterminal heads, 220 × 3 μm (A.H.: 254 μm); a second category (?) of tylostyles is 10–20% longer than the first and has a second swelling about 80 μm down the shaft, or has only this mid-shaft swelling and none at the rounded end. (b) Microrhabds, strongly spined, with spines having blunt ends, straight, bent or angulated, 35 × 3 μm (A.H.: 42 μm), with a range of 15–55 μm in length, 2–4 μm in width.

*Remarks.*—Topsent (1891:569) synonymized this species with *Cliona lobata* Hancock.

### *Cliona insidiosa* Hancock
Fig. 2e

*Cliona insidiosa* Hancock, 1849:333, pl. XV, fig. 5.

*Material examined.*—5 slides (acid cleaned); A.H. no. 25, all dated 1858.

*Syntypes.*—4.15.40–4.15.44.

*Type locality.*—Not stated (substrate: "*Tridacna gigas*").

*Spicules.*—Tylostyles only, robust, with rounded heads, many heads distally flattened, 250 × 10 μm (A.H.: 217 μm).

*Remarks.*—Two other kinds of spicules are present on some of the slides but are here regarded as contaminants because they are not consistently and closely associated with the tylostyle clusters: abundant smooth oxea, 120 × 6 μm, resembling the spicules of *Cliona labyrinthica* Hancock; and rare spiny microrhabds, 55 × 2.5 μm, resembling those occurring in *Cliona lobata* Hancock.

### *Cliona labyrinthica* Hancock
Fig. 7c

*Cliona labyrinthica* Hancock, 1849:345, pl. XV, fig. 7.

*Material examined.*—4 slides (acid cleaned); A.H. no. 30, all dated 1858.

*Syntypes.*—4.15.45–4.15.48.

*Type locality.*—Not stated (substrate: "*Tridacna gigas*").

*Spicule.*—Oxeas only, 2 size classes, 120 × 10 μm and 110 × 5 μm (A.H.: 109 μm). The larger category has a characteristic shape, stout and curved, with mucronate tips.

*Remarks.*—Laubenfels (1936:155) transferred this species to his genus *Aka,* a new name for the preoccupied *Acca* Johnson. Indeed, shape and size of the characteristic oxea on Hancock's slides (unfortunately, there is no tissue mount) agree well with figures and descriptions of *Acca* species (Johnson 1899:461–462, figs. 1–4). On the other hand, they are also in close agreement with observations on *Siphonodictyon* species, *S. obruta* in particular, described by Rützler (1971). We therefore conclude that *Acca* (to be replaced by *Aka*) is a senior synonym of *Siphonodictyon.*

### *Cliona lobata* Hancock
Fig. 3c, d

*Cliona lobata* Hancock, 1849:341, pl. XII, figs. 4 & 8; 1867:239, pl. VII, fig. 6.

*Material examined.*—4 slides (3 acid-treated squash preparations, 1 tissue squash). Only one slide (acid treated squash) bears Hancock's no. 5; the other three were later provided by Mr. Charles Adamson from Scotland (Hancock 1867:239) and are so designated.

*Syntypes.*—4.16.01.

*Additional material.*—4.16.02–4.16.04.

*Type locality.*—Guernsey, English Channel.

*Spicules.*—(a) Tylostyles, most with subterminal heads, 200 × 5 μm (A.H.: 254 μm). (b) Microrhabds, spiny and zigzagged, obtuse-ended, apparently in two size classes; 50 × 4 μm (A.H.: 51 μm) and 15 × 3 μm.

*Remarks.*—The tylostyles on the holotype slide are much shorter than noted by Hancock who measured "1/100th of an inch" (Hancock 1849:342); on the other slides these spicules are even shorter (180 × 5 μm). Despite some suggestions to synonymize this species with *Cliona celata* Grant (Bowerbank 1866:12; Vosmaer 1933: 349, 362) most authors treat it as good species, readily distinguishable from the latter (Topsent 1900:70; Hartman 1958:19).

### *Cliona mazatlanensis* Hancock
Fig. 6a, b

*Cliona mazatlanensis* Hancock, 1867:240, pl. VIII, fig. 1.

*Material examined.*—2 slides (acid cleaned), from one specimen (without A.H. no., but both dated 1867).

*Holotype* (by monotypy).—4.16.05, 4.16.06.

*Type locality.*—Mazatlan, Pacific Mexico.

*Spicules.*—(a) Tylostyles with rounded heads, 200 × 5 μm (A.H.: 145 μm). (b) Oxea, microspined, 100 × 3 μm (A.H: "half the length of the former"). (c) Microrhabds, microspined, straight to wavy with 2–3 bends, 10 × 2 μm (A.H: 20 μm).

*Remarks.*—Spicule measurements in the original publication are obviously in error, except that the oxea are indeed "half the length" of the tylostyles. This species was synonymized with *Cliona vastifica* Hancock (Topsent 1891:565).

### *Cliona millepunctata* Hancock
Fig. 2f

*Cliona millepunctata* Hancock, 1849:341, pl. XII, fig. 9.

*Material examined.*—2 slides (acid cleaned), from one specimen; A.H. no. 15, dated 1858.

*Holotype* (by monotypy).—4.16.07, 4.16.08.

*Type locality.*—Not stated (substrate: "*Cassis tuberosa*").

*Spicule.*—Tylostyles only, very weakly silicified, 210 × 2 μm (A.H.: 181 μm).

*Remarks.*—There are only few intact spicules on the slides. This species has been all but ignored by subsequent authors.

### *Cliona muscoides* Hancock
Fig. 6g

*Cliona muscoides* Hancock, 1849:335, pl. XV, fig. 11.

*Material examined.*—2 slides (acid cleaned) from one specimen; A.H. no. 11, both dated 1858.

*Holotype* (by monotypy).—4.16.09, 4.16.10.

*Type locality.*—Not stated (substrate: "*Monoceros fusoides*").

*Spicules.*—(a) Tylostyles, 180 × 4 μm (A.H.: 181 μm); the majority with one terminal head and a second swelling about 20 μm below the first; a few have a third swelling further down the shaft, others have only one swelling which is subterminal. (b) Oxea, microspined, with a sharp central bend and almost all centrotylote, 110 × 4 μm. (c) Microrhabds, microspined and centrotylote, 13 × 1.5 μm.

*Remarks.*—The fact that Hancock missed the microrhabds was already suspected by Vosmaer (1933:403, 411), who tentatively synonymized the species with *Cliona vastifica* Hancock. The consistent presence of tylote swellings in all spicules, even the microrhabds, is certainly remarkable.

### *Cliona nodosa* Hancock
Fig. 7d

*Cliona nodosa* Hancock, 1849:344, pl. XV, fig. 10.

*Material examined.*—4 slides (acid cleaned); three bear a single number (A.H. no. 24), the fourth, unusually, bears three numbers (A.H. nos. 24, 26, 31); all are dated 1858.

*Syntypes.*—4.16.11–4.16.14.

*Type locality.*—Not stated (substrate: "*Tridacna gigas*").

*Spicules.*—Oxeas only, 2 size classes, 170 × 9 μm and 150 × 5 μm (A.H.: 145 μm); oxeas are bent rather sharply in the center.

*Remarks.*—This species was transferred to *Aka* by Laubenfels (1936:155); the same comments apply that were given above for *Cliona labyrinthica* Hancock. A fourth slide in the series (4.16.14) contains a mixture of styles, tylotes, oxeas, tylostyles, *Thoosa*-type amphiasters, sigmas, and toxas; it is useless for the characterization of *Cliona nodosa* Hancock.

### *Cliona northumbrica* Hancock
Fig. 5e, f

*Cliona northumbrica* Hancock, 1849:336, pl. XIV, fig. 5; 1867:237, pl. VII, fig. 1.

*Material examined.*—9 slides; three from the original specimen (2 acid cleaned, 1 tissue squash) bear Hancock's number (A.H. no. 17), and are dated 1858; three from additional specimens without A.H. nos. (2 acid cleaned, dated 1858, 1 squash, dated 1867) collected later "from oysters" from Scotland(?) (Hancock 1867:237); one labelled like the original preparation but obviously incorrectly.

*Syntypes.*—4.16.15–4.16.17.

*Additional material.*—4.16.18–4.16.23.

*Type locality.*—Cullercoats' haddock grounds, off the northeast coast of England.

*Spicules.*—(a) Tylostyles, straight with large round heads, 330 × 7 μm (A.H.: 330 μm). (b) Oxea, microspined, regular or sharply bent in the center, 110 × 5 μm (A.H.: 82 μm). (c) Microrhabds, microspined, wavy, 14 × 3 μm (A.H.: 14 μm); most of these microscleres have 4–5 bends, but some have only slight bend, others are S- or W-shaped.

*Remarks.*—The label of one slide of the series (4.16.23) has been crossed out in pencil and, indeed, the spicules do not agree with the species description (only tylostyles are present, 450 × 9 μm, which resemble those of typical *Cliona celata* Grant). Topsent (1888:46) puts *Cliona northumbrica* into synonymy with *C. vastifica* Hancock.

### *Cliona purpurea* Hancock
Fig. 7e, f

*Cliona purpurea* Hancock, 1849:343, pl. XII, fig. 6.

*Material examined.*—2 slides (acid cleaned); A.H. no. 21, both dated 1858.

*Syntypes.*—4.16.24, 4.16.25

*Type locality.*—Not stated (substrate: "*Tridacna gigas*").

*Spicules.*—(a) Tylotes, with unpronounced terminal swellings, spined at both ends, 260 × 5 μm (A.H.: 254 μm). (b) Acanthotornotes, 120 × 5 μm (A.H.: 127 μm); their lengths having a considerable range (60–170 μm). (c) Isocheles, palmate, 18 μm. (d) Toxa, all broken, 75 μm estimated length, about 1 μm thick.

*Remarks.*—Hancock, in the original description, did not note the microscleres. Kirkpatrick (1900:353) subsequently studied the type, also overlooked the microscleres, and thus transferred the species to his new genus *Dyscliona*; he did, however, confirm the boring habit of this sponge. Topsent (1907), primarily interested in the purple pigmentation of *Cliona purpurea,* obtained a fragment of the type and described and illustrated the entire spicule complement, including isocheles and toxa

(Topsent 1907:XIX); he determined that *Dyscliona* was not the appropriate genus to receive *purpurea.* Hallman (1920:772), finally, established *Paracornulum* for *Cornulum dubium* Hentschel and transferred *Cliona pupurea* to this genus.

### *Cliona quadrata* Hancock
Fig. 3g, h

*Cliona quadrata* Hancock, 1849:344, pl. XV, fig. 6.

*Material examined.*—2 slides (acid cleaned); A.H. no. 20, both dated 1858.

*Syntypes.*—4.16.26, 4.16.27.

*Type locality.*—Not stated (substrate: "*Tridacna gigas*").

*Spicules.*—(a) Tylostyles, fusiform, with round head well set off from the shaft, 380 × 25 μm (A.H.: 363 μm). (b) Amphiasters, most with 5–7 rays delicately branched at the ends, 25 μm in total length.

*Remarks.*—Several authors misinterpreted this species because no microscleres were known (Vosmaer 1933:345, 356, 382, 383). This reexamination, revealing the characteristic amphiasters, places *Cliona quadrata* clearly into the genus *Cliothosa* Topsent.

### *Cliona radiata* Hancock
Fig. 2g, h

*Cliona radiata* Hancock, 1849:334, pl. XV, fig. 3.

*Material examined.*—2 slides (acid cleaned); A.H. no. 6.

*Syntypes.*—4.16.28, 4.16.29.

*Type locality.*—Not stated (substrate: "*Triton variegatus*").

*Spicule.*—(a) Tylostyles, consistently with subterminal heads, 290 × 8 μm (A.H.: 289 μm). (b) Raphids, ca. 100 μm in length (mostly broken).

*Remarks.*—Raphids were not noted in the original description. This species is generally considered a synonym of *Cliona celata* Grant (Vosmaer 1933:361, 362).

### *Cliona rhombea* Hancock
Fig. 4e, f

*Cliona rhombea* Hancock, 1849:342, pl. XII, fig. 7.

*Material examined.*—2 slides (acid cleaned); A.H. no. 27, one dated 1858, the other undated.

*Syntypes.*—4.16.30, 4.16.31.

*Type locality.*—Not stated (substrate: "*Tridacna gigas*").

*Spicules.*—(a) Tylostyles, straight, with rounded heads, 300 × 7 μm (A.H.: 292). (b) Oxea, microspined, bent in the center, 130 × 5 μm (A.H.: 146 μm). (c) Microrhabds, microspined, spindle shaped, straight or slightly curved, 12 × 2 μm.

*Remarks.*—The microrhabds were not noted in the original description. Vosmaer (1933:411), suspecting this oversight, synonymized the species with *Cliona vastifica* Hancock.

### *Cliona spinosa* Hancock
Fig. 4g, h

*Cliona spinosa* Hancock, 1849:339, pl. XIII, figs. 5–7.

*Material examined.*—4 slides (acid cleaned), all labelled as [A.H.] no. 10 and dated 1858; one "from *Perna*" (4.16.32) was used for the original figures (Hancock 1849: 339).

*Syntypes.*—4.16.32–4.16.35.

*Type locality.*—Not stated (substrates: "*Perna femoralis*" and "*Placuna sella*").

*Spicules.*—(a) Tylostyles, straight, with round heads, 290 × 5 μm (A.H.: 292 μm). (b) Oxea, microspined, bent in the center, 120 × 5 μm (A.H.: 97 μm). (c) Microrhabds, microspined, 17 × 2 μm.

*Remarks.*—The microrhabds were not described originally. Again, Vosmaer (1933: 411) concluded that they were overlooked and synonymized *Cliona spinosa* with *C. vastifica* Hancock.

### *Cliona vastifica* Hancock
Fig. 6c, d

*Cliona vastifica* Hancock, 1849:342, pl. XV, fig. 2; 1867:237, pl. VII, fig. 2.

*Material examined.*—4 slides (acid cleaned tissue squash, as well as spicule spreads), presumably of material teased from a number of different specimens, but certainly all from the same species. All without A.H. nos. and date, labelled in style 2.

*Syntypes.*—4.16.36–4.16.39.

*Type locality.*—Prestonpans?, Firth of Forth, Scotland.

*Spicules.*—(a) Tylostyles, straight with round heads, 300 × 5 μm (A.H.: 292 μm). (b) Oxea, microspined, slightly bent, 100 × 3 μm (A.H.: 97 μm). (c) Microrhabds, microspined, straight spindleshaped, or S- or W-shaped, 12 × 3 μm (A.H.: 12 μm).

*Remarks.*—Though the slides lack date and original number they all agree closely in spiculation and accord well with Hancock's description. This species has been generally accepted as valid (refer to Hartman 1958).

### *Cliona vermifera Hancock*
Fig. 3e, f

*Cliona vermifera* Hancock, 1867:239, pl. VIII, fig. 2.

*Material examined.*—3 slides (acid cleaned); two from "*Chama* no. 2," one from "*Chama* no. 3." All dated 1867, labelled in style 2.

*Syntypes.*—4.16.40–4.16.42.

*Type locality.*—Not stated (substrate: "*Chama*").

*Spicules.*—(a) Tylostyles, robust with mainly subterminal heads, two size classes, 300 × 7.5 μm and 220 × 11 μm (A.H.: 254 μm). (b) Rhabds, smooth, spiralled or undulated, with 3–5 bends and obtuse extremities, 60 × 4 μm (A.H.: 64 μm).

*Remarks.*—Generally considered a good species with constant spicule characteristics.

### *Thoosa* Hancock
### *Thoosa bulbosa* Hancock
Fig. 7a

*Thoosa bulbosa* Hancock, 1849:346, pl. XII, figs. 10 & 11; pl. XIII, fig. 8.

*Material examined.*—10 slides (7 acid cleaned and 3 tissue squashes); A.H. nos. 22a & 22b, and unnumbered from "*Chama*" and "*Tridacna*" (7 dated 1858, labelled style 1; 3 undated, labelled style 2).

*Syntypes.*—4.16.43–4.16.48, 4.17.01–4.17.04.

*Type locality.*—Not stated (substrates: "*Tridacna gigas,*" mentioned in description, and "*Chama,*" noted on some labels).

*Spicules.*—All slides have at least the amphiasters in common. (a) Amphiasters of six-rayed type, with 14 microspined nodules, 25 × 17 μm. (b) Oxyasters, smooth or microspined, reduced to biradiate ("bird wings"), triradiate, or tetraradiate forms; ray dimensions 70 × 2.5 μm (A.H.: 86 μm). (c) Oxyasters (can be rare or absent), microspined, with lanceolate ray tips; ray dimensions 25 × 2 μm. (d) Oxeas, centrotyle (150 × 2.5 μm) or regular (200 × 8 μm); not necessarily proper to the species.

*Remarks.*—Topsent (1888:81) and Volz (1939:30) both commented on the great variety of spicules encountered in sponges of this genus.

### *Thoosa cactoides* Hancock
Fig. 7b

*Thoosa cactoides* Hancock, 1849:345, pl. XIII, figs. 1 & 2.

*Material examined.*—2 slides (acid cleaned) from one specimen; without A.H. no., dated 1858.

*Holotype* (by monotypy).—4.17.05, 4.17.06.

*Type locality.*—Not stated (substrate: "*Meleagrina margaritifera*").

*Spicules.*—Amphiasters are the only preserved type; they are smaller and stouter than in the previous species, 23 × 15 $\mu$m (A.H.: 145 × 109 $\mu$m).

Remarks.—Hancock's spicule measurements ("1/175th of an inch long and 1/234th of an inch broad") are obviously in error. This species is the type of the genus. It is regrettable that no other spicule types were described or preserved but the amphiasters.

## Conclusions

Examination of the Hancock material sheds considerable new light on spicule details preserved in this pioneering collection but, unfortunately, it does not solve species problems in clionid sponges. We should, however, highlight some of our findings to provide basic information for those who might plan experimental ecological work involving this group.

Species containing tylostyles only are particularly difficult to interpret. Traditionally, but in many cases without justification, these have been synonymized with *Cliona celata* Grant. They include *Cliona alderi, C. angulata, C. globulifera, C. gorgonioides, C. insidiosa, C. millepunctata,* and *C. radiata.* The latter species seems to contain raphids in addition to tylostyles, a characteristic not unusual for some populations of bona fide *C. celata* (Volz 1939) but also confirmed for another species, *C. amplicavata* Rützler (1974).

Tylostyles accompanied by spiny rhabds or spirasters are found in *Cliona howsei* and *C. lobata.* Tylostyles are very similar in both but spiny rhabds are shorter and rather straight in the former, longer and undulating in the latter. Tylostyles and smooth wavy rhabds are present in *C. vermifera,* one of the few species almost never doubted in the literature. Tylostyles joined by amphiasters are characteristic of *C. quadrata* and allows us to transfer this species to the genus *Cliothosa.* Finally, knobby amphiasters without the company of tylostyles (albeit presence of several other spicule types) confirm the validity of the curious genus *Thoosa,* with species *T. bulbosa* and *T. cactoides,* most likely distinct from each other.

By far the largest species complex in the collections is represented by specimens containing three spicule types: tylostyles, microspined oxeas, and microspined microrhabds. Hancock described 14 species with this spicule combination although he recognized the microrhabds in only six. Subsequent authors maintained only two of these species as valid, *Cliona carpenteri* with straight fusiform microrhabds, and *C. vastifica* with angulated microrhabds; all other species were placed in synonymy with *C. vastifica.*

If one examines the spicules of species in the *Cliona vastifica* complex one finds great variability among all types but very little correlation between characters, such as relative sizes, position of swelling on the tylostyles, and spination and shape of oxea and microrhabds. Using spicule characteristics alone one can group the following: (1) *C. carpenteri, C. dendritica, C. rhombea,* and *C. spinosa* (straight spindle-shaped microrhabds); species described much later, such as *C. robusta* Old (1941:9), *C. truitti* Old (1941:10), and *C. lampa* Laubenfels (1950:110) could be adjoined here. (2) *C. corallinoides, C. gracilis, C. northumbrica,* and *C. fryeri* (with zigzagged microrhabds of commonly 3–5 bends); *C. spirilla* Old (1941:10) belongs here as well. (3) *C. mazatlanensis* and *C. vastifica* (with angulated microrhabds of 2–3 bends). (4) *C. canadensis* and *C. muscoides* (with centrotyl microrhabds, centrotyl oxea, and tylostyles with multiple swellings); *C. robusta* Old (1941:9) also fits this group. (5) *C. cervina* (with two size classes of microrhabds and coarse tuberculation—microspine clusters—on both microrhabds and oxea).

Unfortunately, many transitions in size and shape of spicules are present and no

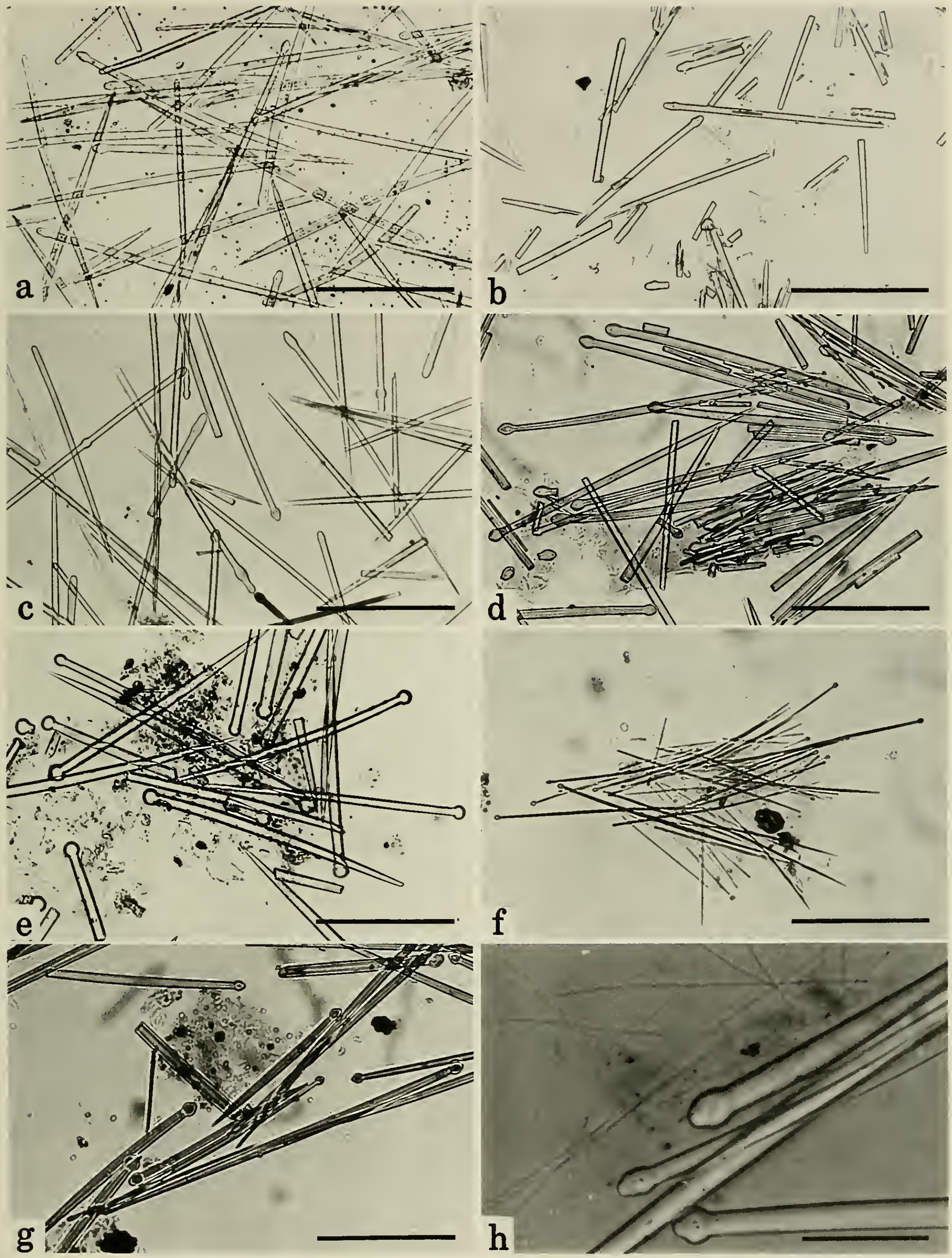

Fig. 2. Photomicrographs of spicules: a, *Cliona alderi,* tylostyles; b, *C. angulata,* tylostyles; c, *C. globulifera,* tylostyles; d, *C. gorgonioides,* tylostyles; e, *C. insidiosa,* tylostyles; f, *C. millepunctata,* tylostyles; g, *C. radiata,* tylostyles; h, *C. radiata,* tylostyle heads and raphides. Scales: a–g, 100 μm; h, 25 μm.

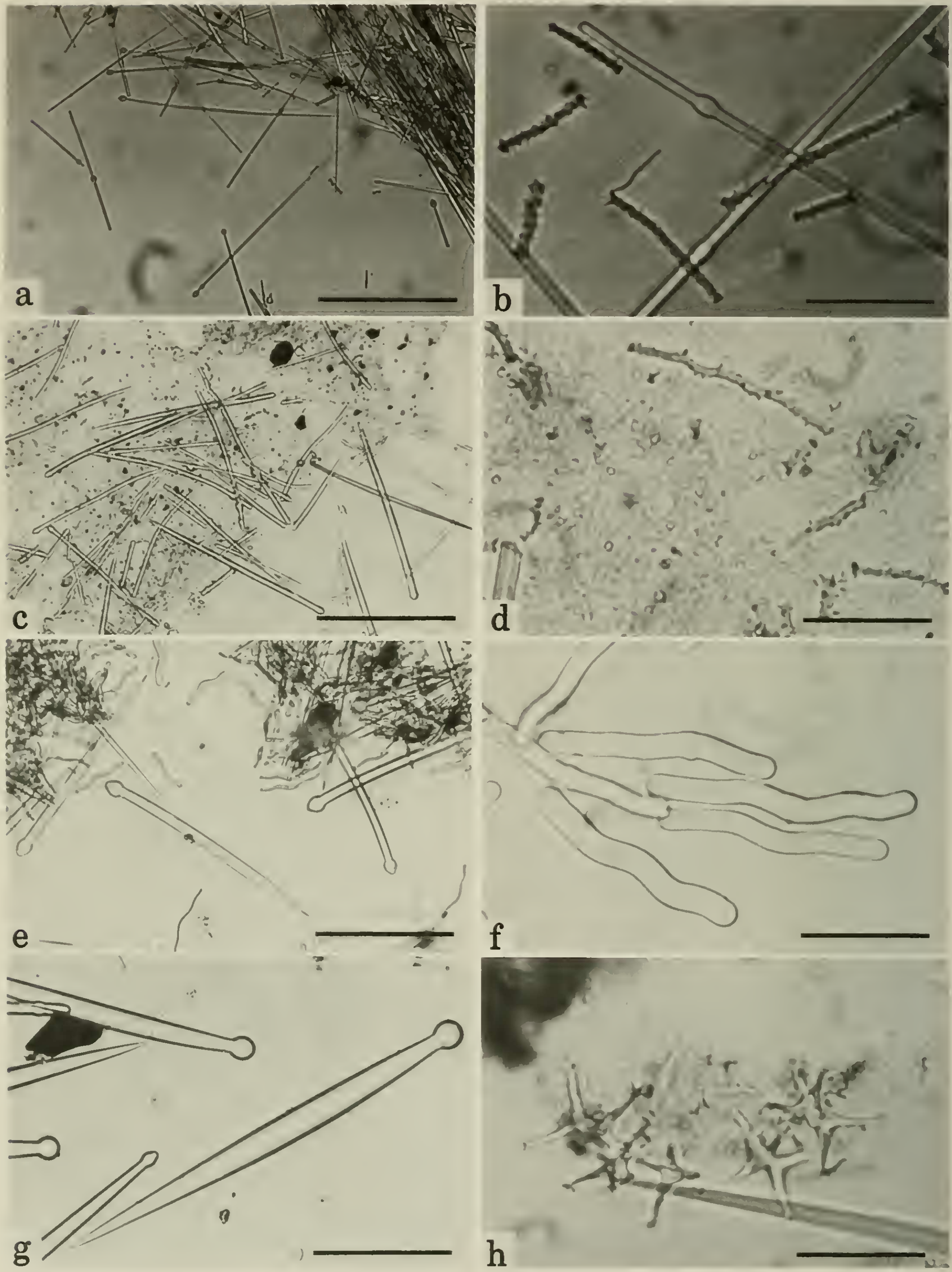

Fig. 3. Photomicrographs of spicules: a, *Cliona howsei*, tylostyles; b, *C. howsei*, spined microrhabds; c, *C. lobata*, tylostyles; d, *C. lobata*, spiny microrhabds; e, *C. vermifera*, tylostyles; f, *C. vermifera*, smooth spiralled rhabds; g, *C.* (=*Cliothosa*) *quadrata*, tylostyles; h, *C.* (=*Cliothosa*) *quadrata*, amphiasters. Scales: a, c, e, g, 100 μm; b, d, f, h, 25 μm.

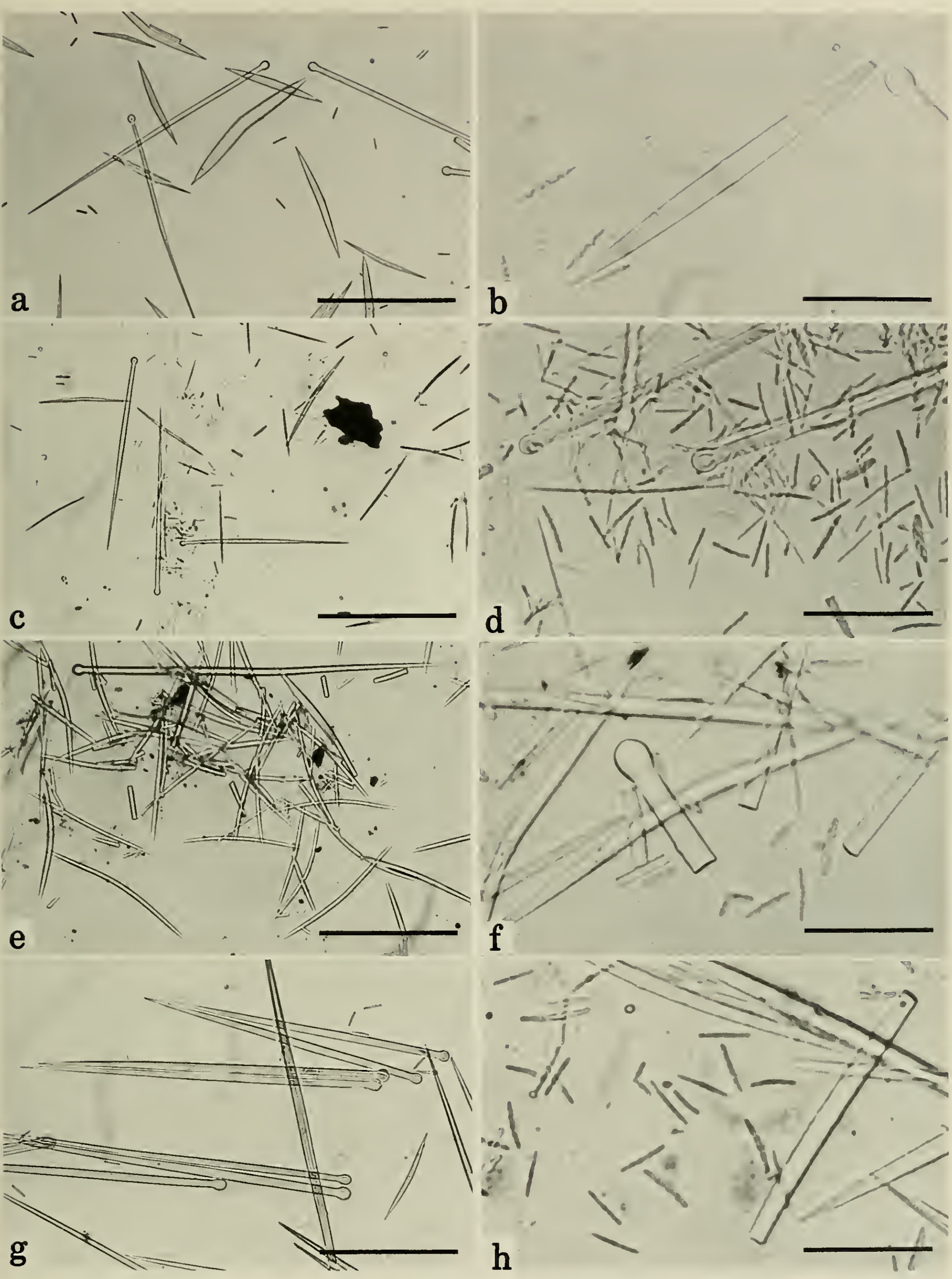

Fig. 4. Photomicrographs of spicules: a, *Cliona carpenteri,* tylostyles and microscleres; b, *C. carpenteri,* microspined oxea and microrhabds; c, *C. dendritica,* tylostyles and microscleres; d, *C. dendritica,* tylostyle heads, microspined oxeas and microrhabds; e, *C. rhombea,* tylostyle and microscleres; f, *C. rhombea,* tylostyle head, microspined oxeas, and microrhabds; g, *C. spinosa,* tylostyles and microscleres; h, *C. spinosa,* microspined oxeas and microrhabds. Scales: a, c, e, g, 100 μm; b, d, f, h, 25 μm.

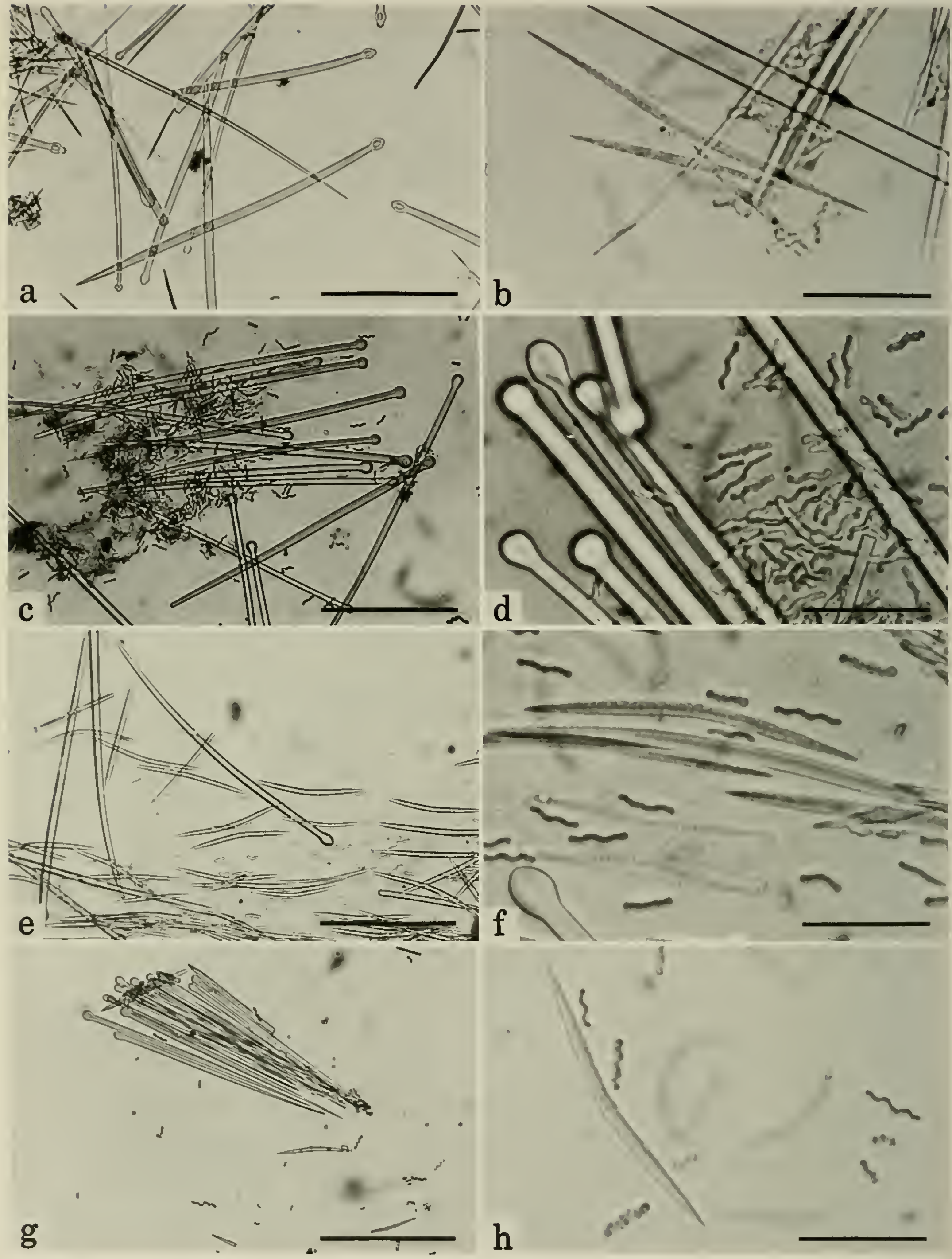

Fig. 5. Photomicrographs of spicules: a, *Cliona corallinoides,* tylostyles; b, *C. corallinoides,* microspined oxeas and microrhabds; c, *C. gracilis,* tylostyles and microscleres; d, *C. gracilis,* tylostyle heads and microspined microrhabds; e, *C. northumbrica,* tylostyles and microscleres; f, *C. northumbrica,* microspined oxeas and microrhabds; g, *C. fryeri,* tylostyles and microscleres; h, *C. fryeri,* microspined oxea and microrhabds. Scales: a, c, e, g, 100 μm; b, d, f, h, 25 μm.

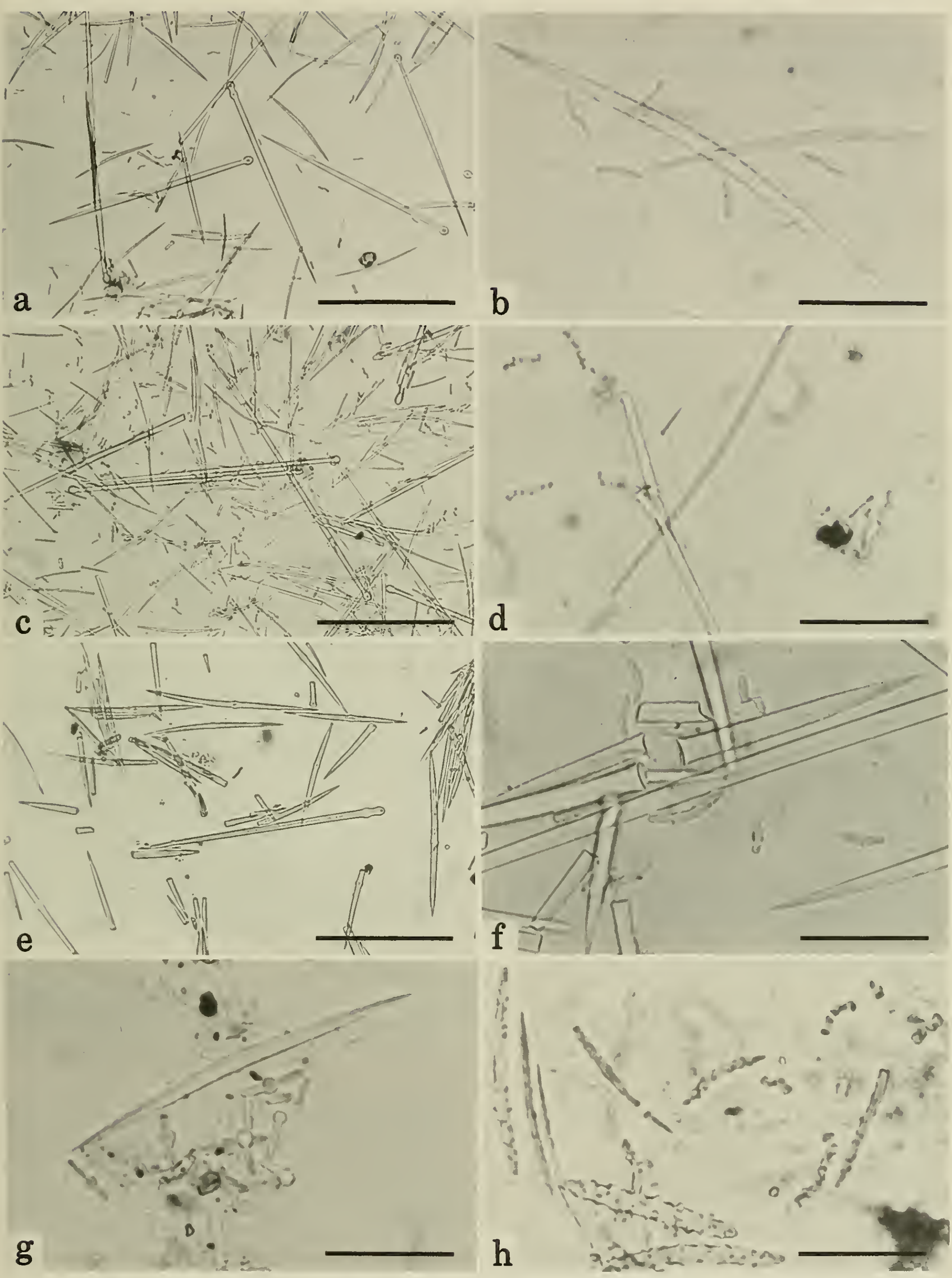

Fig. 6. Photomicrographs of spicules: a, *Cliona mazatlanensis,* tylostyles and microscleres; b, *C. mazatlanensis,* microspined oxeas and microrhabds; c, *C. vastifica,* tylostyles and microscleres; d, *C. vastifica,* microspined oxeas and microrhabds; e, *C. canadensis,* tylostyles and microscleres; f, *C. canadensis,* microspined oxeas and microrhabds; g, *C. muscoides,* microspined oxea and centrotylote microrhabds; h, *C. cervina,* tuberculated oxea and microrhabds bearing microspine clusters. Scales: a, c, e, 100 μm; b, d, f–h, 25 μm.

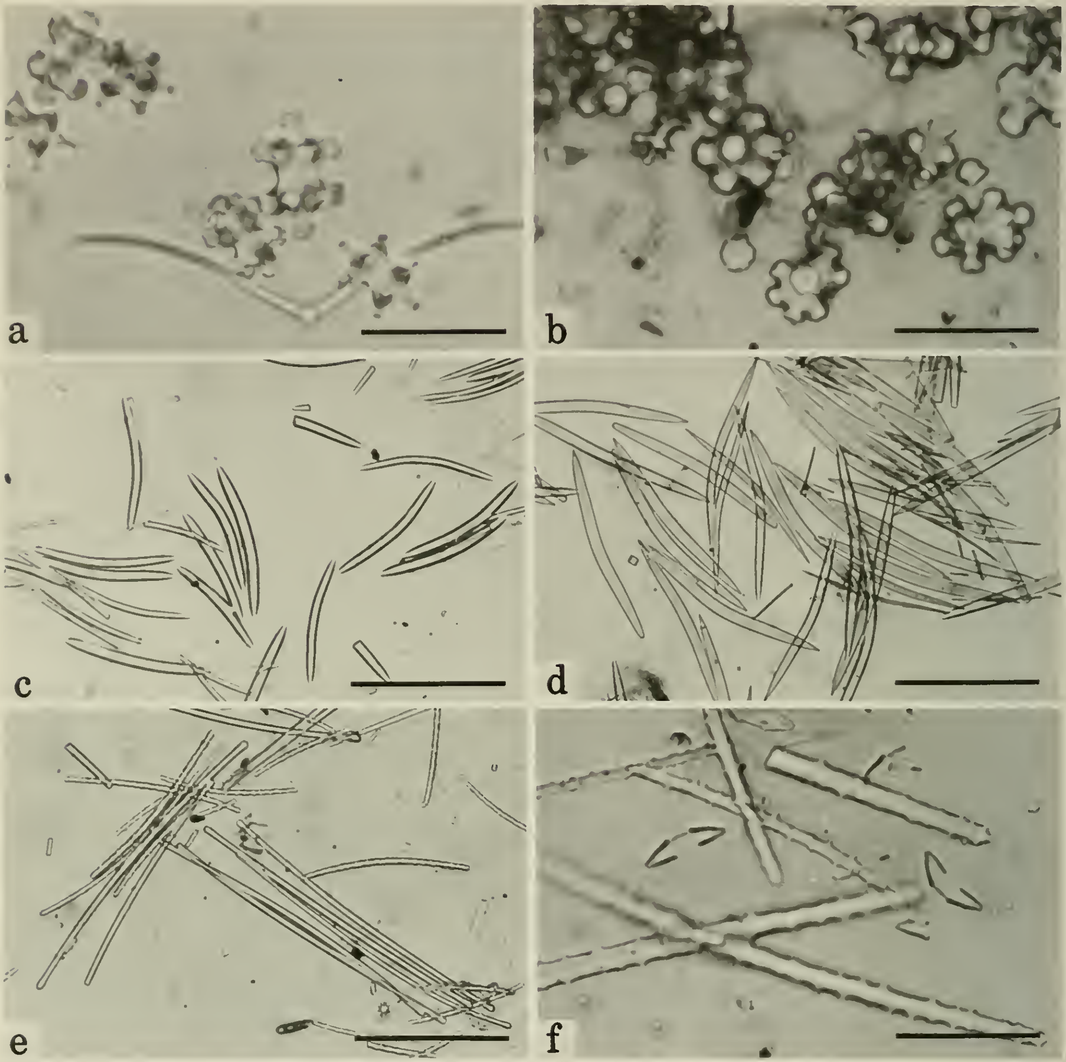

Fig. 7. Photomicrographs of spicules: a, *Thoosa bulbosa,* amphiasters and reduced oxyaster ("bird wing"); b, *T. cactoides,* amphiasters; c, *Cliona* (=*Aka*) *labyrinthica,* oxeas; d, *C.* (=*Aka*) *nodosa,* oxea; e, *C.* (=*Paracornulum*) *purpurea,* tylotes and acanthotornotes; f, *C.* (=*Paracornulum*) *purpurea,* acanthotornotes and palmate isocheles. Scales: a, b, f, 25 μm; c, d, e, 100 μm.

final conclusions can be drawn without study of fresh and complete material, entire populations, and knowledge of environmental parameters. Topsent (1932:558) already had evidence that environmental conditions, such as salinity, can modify the spiculation of *Cliona vastifica.* Availability of dissolved silicic acid is another important factor known to influence spicule shape and size (Simpson 1981). On the other hand, populations of *Cliona lampa* (group (1), above) studied in Bermuda (Rützler 1974) display very stable spicule characteristics but turn out to represent two distinct species distinguishable by color, spicule size, and growth habit, as confirmed by long term observations and field experiments (Rützler, in prep.).

Excavating sponges described by Hancock but not belonging to the *Clionidae* are

*Cliona labyrinthica* and *C. pupurea.* The former, transferred to *Aka,* is now viewed by us as a member of the Oceanapiidae (Haplosclerida), and the latter, transferred to *Paracornulum,* may belong to the Coelosphaeridae (Poecilosclerida).

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(KR) Department of Invertebrate Zoology, National Museum of Natural History, Smithsonian Institution, Washington, D.C. 20560; (SMS) Department of Zoology, British Museum (Natural History), Cromwell Road, London SW7 5BD, England.